Keio University

Thesis Abstract

No.

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Title of Thesis:

A Semantic Deforestation Interpretation System with the Closest Semantic-Ellipsoid Algorithm and L-Band Synthetic Aperture Radar Satellite Images

Summary of Thesis:

This dissertation deals with the problem to interpret deforestation phenomena. The detection of deforestation by remote sensing technologies has been one of the most important research issues in forest monitoring over the last decades. However, only identifying the area of change is usually not sufficient to understand how critical the effects are on the environment. The expert knowledge should be added to the system to compute the interpretation and monitor its impacts. On the other hand, capability to monitor and understand deforestation is limited due to a complex phenomenon in deforestation phenomena: (1) Complexity in detecting (2) Uncertainty ecological effect, and (3) Dynamic situation.

This dissertation proposes the deforestation interpretation system based on Semantic Dimensional Control with features: (1) sensing and processing in one single space, (2) gamma-naught value based clustering algorithm, (3) interpretation of deforestation area by the novel Closest Semantic-Ellipsoid Algorithm, and (4) context-based deforestation analysis. Motivation to build the system is to realize the interpretation of environmental phenomena. The closest semantic-ellipsoid particularly aimed at semantic meaning acquisition of deforestation area.

This dissertation introduces the new approach to detect and interpret deforestation by engagement between sensing and processing computation in the Sensing, Processing, and Actuation (SPA) concept. The sensing procedure is a mechanism to compute and analyse the satellite images and the processing procedure is a mechanism to assign the semantic meaning to deforested area. The deforestation area is a region with the change of forest in t1 to non-forest area t2 and the semantic meaning is a textual unit to interpret the deforestation conditions. The interpretation result of a detected deforestation area in Peru in the context of causes are frequently due to logging or fire. This calculation applied to the satellite data of ALOS-2/PALSAR-2 images from JAXA. To understand the deforestation area, the proposed detection algorithm is performed before the meaning calculation. As a result, deforestation map that indicates the change from forest to non-forest area due to deforestation activity is presented. The result shows that this approach has more information-rich retrieval results.

This dissertation proposed the new system to interpret the deforestation phenomena. There are 5 components of deforestation: the cause, the impact on soil erosion risk, on soil capacity for plantation, carbon emission, and the land cover conversion. Before giving the meaning to deforestation area, the deforestation area need to be detected automatically. This dissertation proposed the new segmentation algorithm to group the deforestation area which is named as Deforestation Detection using L-Band SAR (DELSAR). In deforestation detection using satellite images, there are 2 component that effect the result of detection: seasonal changes and canopy type. DELSAR algorithm uses this two components in the learning process to improve the precision of detection. The algorithm was evaluated by the Global Land Analysis and Discovery (GLAD). The result shows that the algorithm is better than the existing segmentation algorithm. These are the advantages of the proposed algorithm: 1) provide the learning of temporal pattern in five data cycle, 2) Adaptive and sensitive to the seasonal change, 3) good for significant changing in forest area, and 4) provide the distribution segmentation depending on the temporal pattern behavior.

This dissertation presents the semantic meaning in term of deforestation analysis to give deep

interpretation on ecological impacts. The semantic system in this study is constructed by the new extended version of Mathematical Model of Meaning (MMM). This model consists of (a) integration of sensing and processing procedure into an integrated semantic space, (b) subspace selection and (c) context-similarity calculation. Through this system, the effective, information rich meaning is carried out. The novel algorithm, named closest semantic-ellipsoid algorithm, is proposed to address the critical challenges to determine the ecological semantic meaning from the uncertainties condition in the assessment of the impacts of deforestation, which can be seen as a processing procedure. The algorithm calculates the semantic meaning by computing the distance between an observed deforestation area and semantic ellipsoids representing meanings of forest-situations in an ellipsoid form. The system realizes the interpretation of five contexts of deforestation: i) causes, ii) land cover change, iii) soil degradation, iv) soil erosion risk, and v) CO_2 emission.

This dissertation implements integration of analysis for semantic deforestation analysis among three areas in two countries: Peru and Indonesia. By L-Band SAR data provided by Japanese Aerospace Agency, the result indicates the system is feasible to perform semantic interpretation for deforestation activity.

Keywords: *Semantic computing, Interpretation, L-Band SAR, Remote Sensing, Automatic Detection, Deforestation.*